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Reclaiming the Unwanted: Mining Scientific Gold from multi-trap bycatch

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Abstract

Entomology-based research projects often involve setting up mass-collecting traps to obtain large-scale data on species or communities. Many of these projects gather not only the target taxa but also a large amount of bycatch, which often remains untouched or is even disposed of once the project has ended. Here, we have examined bycatch that has been collected in a project to promote biodiversity in the forests of the Swiss Pre-Alps. Multiple traps were set up in three forest reserves near deadwood, to monitor xylobiontic beetles as bioindicators between 2015–2018. The resulting bycatch was analysed about eight years later. Specimens were sorted, prepared, and in most cases identified to species level. From the 1,105 analysed bycatch individuals, we focused on 254 species, representing the groups Arachnida (Araneae, Opiliones) and Hymenoptera (Anthophila, Chrysididae, Eumeninae, Ichneumonidae, Pompilidae, and Sphecidae *sensu lato*). Most samples were recorded in flight interception traps near herb layers and in the tree canopy. Remarkably, we recorded two rare ichneumonid species, *Casinaria dubia* Tschek, 1871 as a first record for Switzerland and *Bioblapsis polita* (Vollenhoven, 1878) as a first record for Switzerland since 1958. Furthermore, we found the rare European spider *Episinus maculipes* Cavanna, 1876, representing a first record for eastern Switzerland. Our study highlights the importance of well curated bycatch samples, even beyond the duration of the project. Future utilization of such samples may provide precious insights into the ecology and distribution of rare taxa.

Key Words

Bees, faunistics, Hymenoptera, insects, Invertebrates, Pre-Alps, spiders, Switzerland

Introduction

Field-based entomological work involves the collection and study of insect species, populations, and ecological communities in habitats (Darling and Packer 1988; Popic et al. 2013; Wheater et al. 2020; Gardarin and Valantin-Morison 2021). Depending on the research question, trapping methods can either be selected as being very specific (e. g. hand netting or exhauster) or covering a broad range of species (e.g. Malaise traps, pan traps or pitfall traps) (Yi et al. 2012). Collection design can therefore contain one or multiple traps, for example, to record the diversity of a particular group such as ground-active arthropods, pollen-collecting Hymenoptera, or parasitic wasps (Santos and Fernandes 2020). However, most trapping methods are known to inevitably result in the

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collection of large numbers of non-target species, commonly referred to as bycatch (Oberprieler et al. 2019). Traditionally regarded as incidental or peripheral to the study's aims, this material is often stored without further examination or simply discarded (Buchholz et al. 2011). Yet, growing evidence suggests that bycatch can provide valuable biological and ecological information, and its inclusion in biodiversity studies could substantially broaden the scope and utility of sampling efforts.

The non-target specimens recovered from different trapping methods often exhibit a wide taxonomic and ecological range, encompassing species that are otherwise difficult to detect or not expected (Spears and Ramirez 2015). For example, while pitfall traps are primarily intended for ground-dwelling taxa, such as spiders or carabid beetles, they also collect various springtail, ant, and mite species (Dolle et al. 2011). Similarly, various forms of interception traps may target parasitic Hymenoptera, but also regularly capture Diptera, Hemiptera, and various beetle groups (Hribar 2020). As such, bycatch can serve as an opportunistic but powerful tool for expanding taxonomic coverage, detecting rare or cryptic species, and building more complete inventories of local biodiversity.

The evaluation of bycatch can expand our entomological and ecological knowledge. In the optimal scenario, these bycatch samples are well preserved and pre-sorted. However, significantly older bycatch samples that were not optimally preserved may still provide valuable insights, particularly when combined with state-of-the-art determination methods and techniques, such as high-resolution imaging, DNA (meta)barcoding, genomics, or AI-assisted identification (Helton et al. 2022; Schneider et al. 2022; Petsopoulos et al. 2024). This flexibility increases the retrospective value of existing collections and sampling campaigns, many of which hold unsorted or unidentified material. However, despite the value of bycatch, it is often not investigated further, either due to a lack of interest or a lack of resources, such as taxonomic expertise or budget. The current shortage of taxonomic specialists, as well as the time and cost required to sort and identify bycatch, means that large portions of bycatch remain untouched in storage, sometimes for decades, representing a significant and underused scientific resource. Furthermore, there is no consensus on how to handle, label, or store bycatch samples properly (Buchholz et al. 2011). Without targeted efforts to incorporate this material into biodiversity assessments, ecological monitoring, or taxonomic research, much of its potential value remains unexplored (Spears and Ramirez 2015).

In this study, we examined the composition and scientific potential of bycatch collected during an investigation into three forest reserves of the Swiss Pre-Alps (Weid, Amden, Seerenwald), where deadwood has been left in place or was managed by the Cantonal Forestry Office St.Gallen (Ehrbar 2022). By 2030, Switzerland intends to protect 10% of its forest area as forest reserves, where management will be focused on the natural development of the forest, without any forestry intervention. This goal is within reach, given that 7.3% of the total forest in Switzerland is already integrated into forest reserves (BAFU 2023). The aim of the original study was to assess xylobiontic beetle diversity as a proxy for evaluating the ecological integrity of natural and special forest reserves. Five different types of traps were used: polytraps and tree crown traps (= flight-interception traps), turpentine traps, beer traps and glue rings. This comprehensive sampling resulted in more than 600 different xylobiontic beetle species (602 Weid, 415 Amden, 573 Seerenwald) representing, for example, rare old-growth relict species or even first records for Switzerland (Huber and Wild 2022a; Huber and Wild 2022b; Huber and Wild 2022c). In addition, a large proportion of non-target taxa were caught and have not yet been studied. Here, we focus on two taxonomic groups sorted out from the bycatch, namely Arachnida and Hymenoptera. These groups are of special interest due to their fundamental ecological importance as predators, parasitoids or pollinators. The bycatch analysed here thus allows deeper insight into species diversity and composition, species distribution at different altitudes, and dark taxa.

Material and methods

Sample collection

Between 2015 and 2018, three forest reserves in the Canton St.Gallen, Switzerland, were surveyed for xylobiontic Coleoptera. Focus was given to the forest reserves of Weid, Seerenwald, and Amden (Table 1; Fig. 1A–C). Each reserve is managed individually. In the natural forest reserve Weid, the authorities try not to interfere with natural processes; lichens, mosses and fungi grow without disturbance and deadwood is left in place. Amden and Seerenwald, however, are reserves where certain target species are promoted. In Amden, for example, particular requirements are established for the capercaillie *Tetrao urogallus* Linnaeus, 1758, resulting in the largest population of this species in northeastern Switzerland (Ehrbar et al. 2015). Seerenwald is known for its lime tree (*Tilia*) communities and their support and protection (Ehrbar 2022).

Five different trap types were used to collect xylobiontic Coleoptera: beer traps, tree crown traps, polytraps, turpentine traps, and glue rings (Duelli et al. 1999; Schaffrath 1999; Valladares 2000; Francese et al. 2011; Egorov et al. 2024) (Fig. 2A–D). The two flight interception traps, poly- and tree crown traps, differed in their placement: Tree crown traps were placed at heights between 4 and 20 meters above ground, while polytraps were positioned near the ground. All traps were placed close to large stocks of deadwood.

An overview of the timing, number of traps per trap type can be found in Table 1. Some traps were baited with various attractants: beer and red wine for the beer trap and turpentine for the turpentine trap. For conservation purposes, salt was added to the collecting cup and acetic acid only for the beer trap (Chénier and Philogène 1989). They

Table 1. Sampling information on the collection time and trap types in the originally studied three forest reserves. Comprehensive details are provided in Suppl. material 1).

Forest reserve	Sampling period	Trap type	Number of traps	Forest reserve [ha]	Elevation [m a.s.l.]
Weid	14.04.2015–20.08.2015	Polytrap	10	34	410–495
		Tree crown trap	8		
		Beer trap	3		
		Turpentine trap	6		
Seerenwald	14.04.2016–06.09.2016	Polytrap	10	79	580–688
		Tree crown trap	10		
		Beer trap	5		
		Glue ring	3		
Amden	16.05.2018–20.08.2018	Polytrap	10	1772	1040–2101
		Tree crown trap	10		
		Beer trap	2		
		Turpentine trap	3		

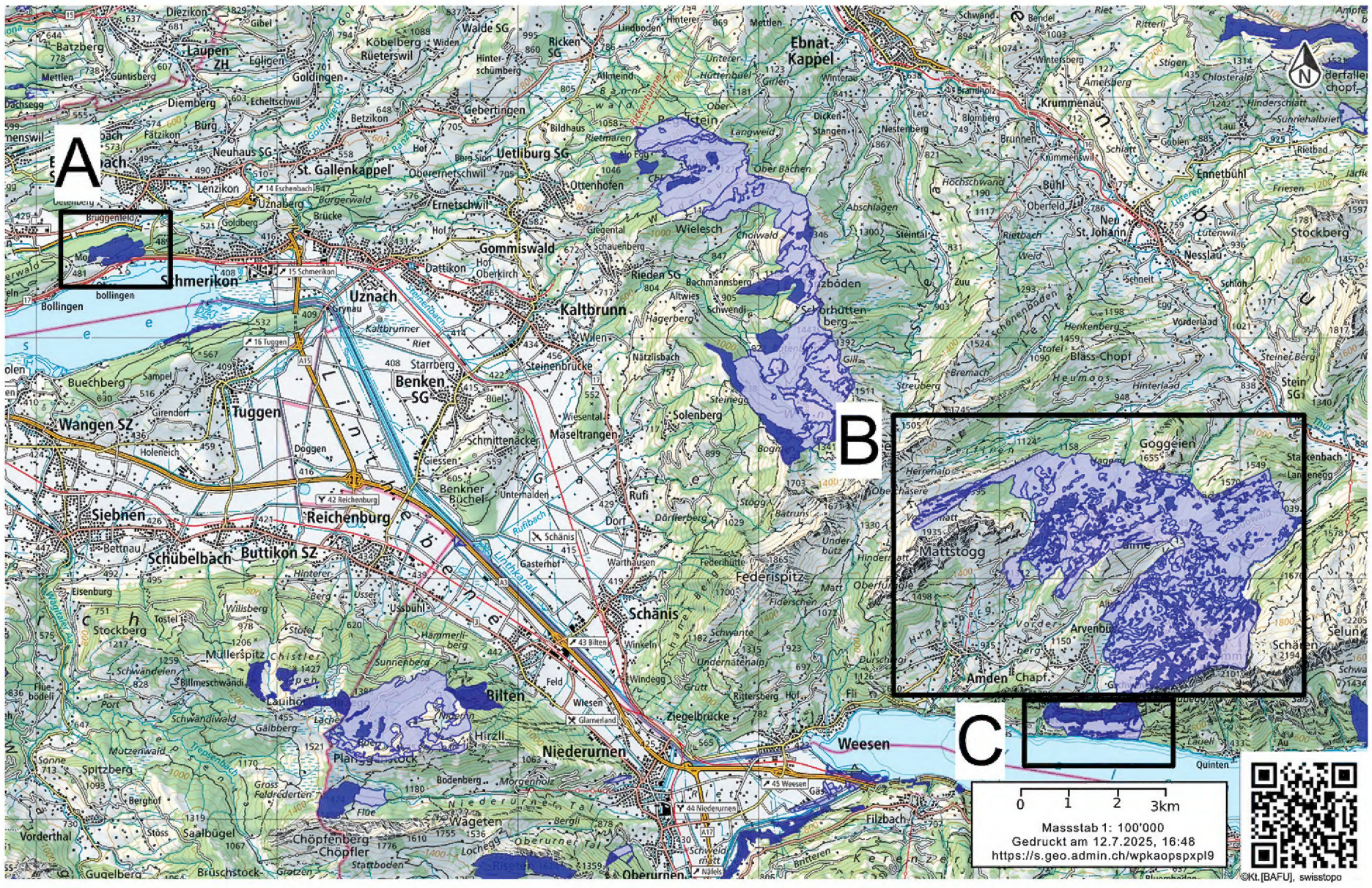

Figure 1. Location and size of the studied forest reserve areas: Weid (**A**), Amden (**B**), and Seerenwald (**C**). Source: Federal Office of Topography swisstopo, BAFU.

were emptied monthly and subsequently refilled over a sampling period lasting 15 to 22 weeks per year. Independent of the traps, hand collection was carried out, though solely targeting beetles. Bycatch specimens caught with glue rings could only be removed from the glue destructively and were not considered in this study. For more details on geocoordinates, sampling periods, trap types, bait composition, and elevation, we refer to Suppl. material 1.

Over the course of three years of collection with the multi-trap system, a total of 389 mixed samples were obtained, covering 158 samples from Weid, 137 from Seerenwald, and 94 from Amden. After sorting all Coleoptera from the bycatch, all samples were preserved in an alcohol-glycerol mixture and sent to the Natural History Museum of St.Gallen. For more information on the three different projects, we refer to (Ehrbar 2022; Huber and Wild 2022a; Huber and Wild 2022b; Huber and Wild 2022c).

Sample preparation and identification

To explore the bycatch, all bycatch samples were re-examined in 2025 and specifically sorted for two groups: Arachnida and Hymenoptera. Arachnida included Araneae and

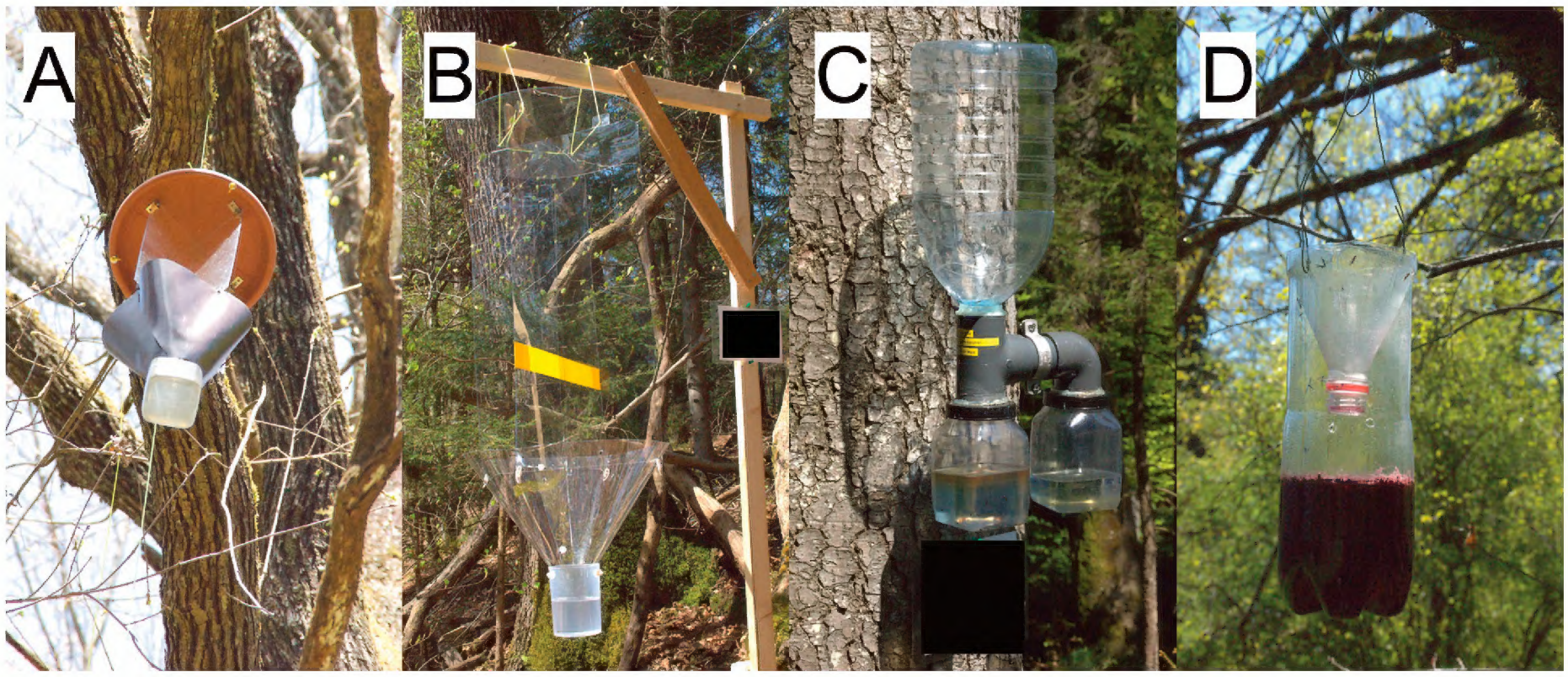

Figure 2. Overview of the different trap types used in the original study on xylobiontic beetles: **A.** Tree crown trap for capturing a broad range of insects flying in the upper canopy; **B.** Polytrap for flying insects; **C.** Turpentine trap, mimicking the scent of coniferous trees to attract wood-dwelling beetles; **D.** Beer trap, filled with sweet and salty liquids to lure flying insects (Pictures © Rolf Ehrbar).

Opiliones, while Hymenoptera encompassed Anthophila, Chrysididae, Ichneumonidae, Pompilidae, Sphecidae *sensu lato*, and Eumeninae. Where feasible, specimens from these groups were determined to species level. All studied specimens were either pinned, mounted on cardboard or preserved in 80% pure ethanol at the Natural History Museum of St.Gallen.

Morphological examinations were conducted using binocular microscopes and relevant identification literature, including: (a) Araneae: Roberts (1987), Nentwig et al. (2025) and Oger (2025); (b) Opiliones: Martens (1978); (c) Anthophila; Amiet et al. (2001, 2004, 2007, 2010, 2014, 2017); (d) Chrysididae: Kunz (1994); (e) Eumeninae: Schmid-Egger (2024); (f) Ichneumonidae: Fitton (1988), Rotheray (1990), Mevi-Schutz (2006), Broad et al. (2018), Riedel (2018), Johansson et al. (2022); (g) Pompilidae: Wolf (1972) and (h) Sphecidae (*s.l.*): Dollfuss (1991), Jacobs (2007). Due to the absence or limited availability of reliable identification keys for certain ichneumonid subfamilies, specimens that could not be identified to the species level were sorted into morphospecies. These specimens were initially intended to be DNA barcoded and divided into OTUs, but preliminary tests showed that DNA quality and quantity was insufficient due to poor preservation of the bycatch samples. Thus, morphospecies were subsequently verified by an expert and regarded as separate species.

Statistical data analyses

Bycatch samples were analysed across the three distinct forest reserves Amden, Seerenwald and Weid by comparing species occurrence and abundance of target taxa among the different trap types. The dataset was organized in a species-by-sample matrix, with rows representing unique combinations of site and trap type and columns representing individual species. All analyses were conducted in RStudio version 2024.12.1 (Posit team 2025) using the packages dplyr version 1.1.4 (Wickham et al. 2025b), ggplot2 version 3.5.2 (Wickham 2016), tidyr version 1.3.1 (Wickham et al. 2025a), and vegan version 2.6.10 (Oksanen et al. 2025). Differences in diversity metrics among sites and trap types were examined using summary statistics and visual inspection. Where appropriate, standard deviations were included as error bars to illustrate variability. To assess alpha diversity, two indices were calculated for each sampling unit, the Shannon diversity index (H') and species richness (S) (Hurlbert 1971). The Shannon diversity index represents the diversity of each taxonomic group for each set, with a higher Shannon index indicating higher diversity (Shannon 1948). Species richness, defined as the number of observed species per sampling unit, was calculated and summarized across the different forest reserves and trap types. Diversity patterns were visualized using boxplots and bar plots generated with ggplot2.

Results

A total of 1105 bycatch individuals were sorted and determined, resulting in 254 taxonomic units (Suppl. material 4). We identified 55 species of Arachnida (51 Araneae (N = 309) and four Opiliones (N = 18)) and 199 species of Hymenoptera (67 Anthophila (N = 472), four Chrysididae (N = 11), 85 Ichneumonidae (N = 189), eight Pompilidae (N = 31), six Eumeninae (N = 21) and 29 Sphecidae *sensu lato* (N = 54)). The abundance of collected specimens varied across both trap types and sampling sites (Fig. 3; Suppl. material 2). Besides the here analysed focus groups we found many other individuals waiting to be analysed, including Mecoptera, Symphyta, Heteroptera and Lepidoptera.

Species richness

Species richness differed among trap types and sites in both Arachnida and Hymenoptera (Tables 2, 3). Site-wise, the highest species richness for Anthophila was found in Amden (S = 21) and Seerenwald (S = 26); for Araneae in Weid (S = 8.75) and Ichneumonidae, the highest richness was found in Seerenwald (S = 19.7) (Table 2). Regarding the different trap types, the highest species richness of Araneae was recorded in polytraps (S = 11). The same was true for all groups of Hymenoptera, except for the Chrysididae and Eumeninae (Table 3).

Shannon Diversity Index

Shannon diversity index averages reflect differences in community composition across trap types and sites (Tables 2, 3). In Araneae, diversity was highest in Seerenwald (H' = 1.63 ± 0.17), followed by Weid (H' = 1.55 ± 0.66) and Amden (1.43 ± 1.24). Within Hymenoptera, diversity varied across the groups, with the highest averages for Anthophila in Seerenwald (H' = 2.88 ± 0.50) and Amden (H' = 2.38 ± 0.62). For Ichneumonidae highest averages were found in Seerenwald (H' = 2.10 ± 0.55). Further information can be found in Table 2. Among the different trap types, the highest averages were found in the polytraps for Araneae (H' = 1.52 ± 0.69), Anthophila (H' = 3.01 ± 0.21), Ichneumonidae (H' = 2.82 ± 0.13), Pompilidae (H' = 0.68 ± 0.96), and Sphecidae *sensu lato* (H' = 1.99 ± 0.31) (Table 3).

Individuals and species composition

Individuals and species composition varied notably by both trap type and site (Fig. 3; Suppl. material 2). For the three most species-rich and individual-rich groups (Araneae, Anthophila and Ichneumonidae), we visualized distribution patterns of the ten most frequently identified species with respect to trap type and altitude level (Fig. 4). Araneae bycatch was especially dominated by species of the family Theridiidae (i.e. *Dipoena melanogaster* (Koch, 1837) and *Episinus maculipes* Cavanna, 1876) and Anyphaenidae (i.e. *Anyphaena accentuata* (Walckenaer, 1802)), particularly in the forest reserves Seerenwald and Weid at low altitude (Suppl. material 3). Most of these species were found in tree crown traps and polytraps (Suppl. material 3). The most dominant Anthophila species belonged to the *Bombus terrestris* species-group, which was most frequently found in the forest reserve of Amden and at low, as well as at high altitude. Similar to the other bee species, most individuals of the *Bombus terrestris*-group were found in polytraps, but almost as often

Table 2. Mean value and standard error of Shannon diversity index (H') and species richness (S) by forest reserve for the identified taxonomic groups. Different shading indicates (a) low diversity (H' < 1.0), (b) medium diversity (1.0 ≤ H' < 2.0) and (c) high diversity (H' ≥ 2.0).

Taxonomic group	Amden		Seerenwald		Weid	
	H'	S	H'	S	H'	S
Araneae	1.43 ± 1.24	7.33	1.63 ± 0.17	7.00	1.55 ± 0.66	8.75
Opiliones	0.86 ± 0.41	2.67	NA	NA	0	1
Anthophila	2.38 ± 0.62	21	2.88 ± 0.50	26	1.69 ± 1.53	15,3
Chrysididae	0.35 ± 0.49	1.50	0	1	0.21 ± 0.37	1.33
Ichneumonidae	NA	NA	2.10 ± 0.55	19.7	1.34 ± 1.33	10.5
Pompilidae	NA	NA	0	1	0.45 ± 0.78	3
Sphecidae s.l.	1.49 ± 0.76	5.50	0.79 ± 0.84	3.00	1.45 ± 0.57	5.25
Eumeninae	0.19 ± 0.32	1.33	0	1	NA	NA

Table 3. Mean value and standard error of Shannon diversity index (H') and species richness (S) by trap type for the identified taxonomic groups. Different shading indicates (a) low diversity (H' < 1.0), (b) medium diversity (1.0 ≤ H' < 2.0) and (c) high diversity (H' ≥ 2.0).

Taxonomic group	Beer trap		Polytrap		Tree crown trap		Turpentine trap	
	H'	S	H'	S	H'	S	H'	S
Araneae	1.21 ± 0.74	4.00	1.52 ± 0.69	11.0	1.40 ± 0.82	8.67	1.15 ± 1.63	5.50
Opiliones	1.33	4	0.56	2	0.69	2	0	1
Anthophila	NA	NA	3.01 ± 0.21	32,6	2.19 ± 0.30	13,6	0	1
Chrysididae	0	1	0.21 ± 0.37	1.33	0.35 ± 0.49	1.50	NA	NA
Ichneumonidae	1.85 ± 0.14	6.5	2.82 ± 0.13	36.5	1.16 ± 0.93	7	0	1
Pompilidae	NA	NA	0.68 ± 0.96	4	0	1	0	1
Sphecidae s.l.	1.04 ± 0.49	3.00	1.99 ± 0.31	8.33	0.66 ± 0.58	2.33	1.10	3.00
Eumeninae	NA	NA	0	1	0.28 ± 0.40	1.50	0	1

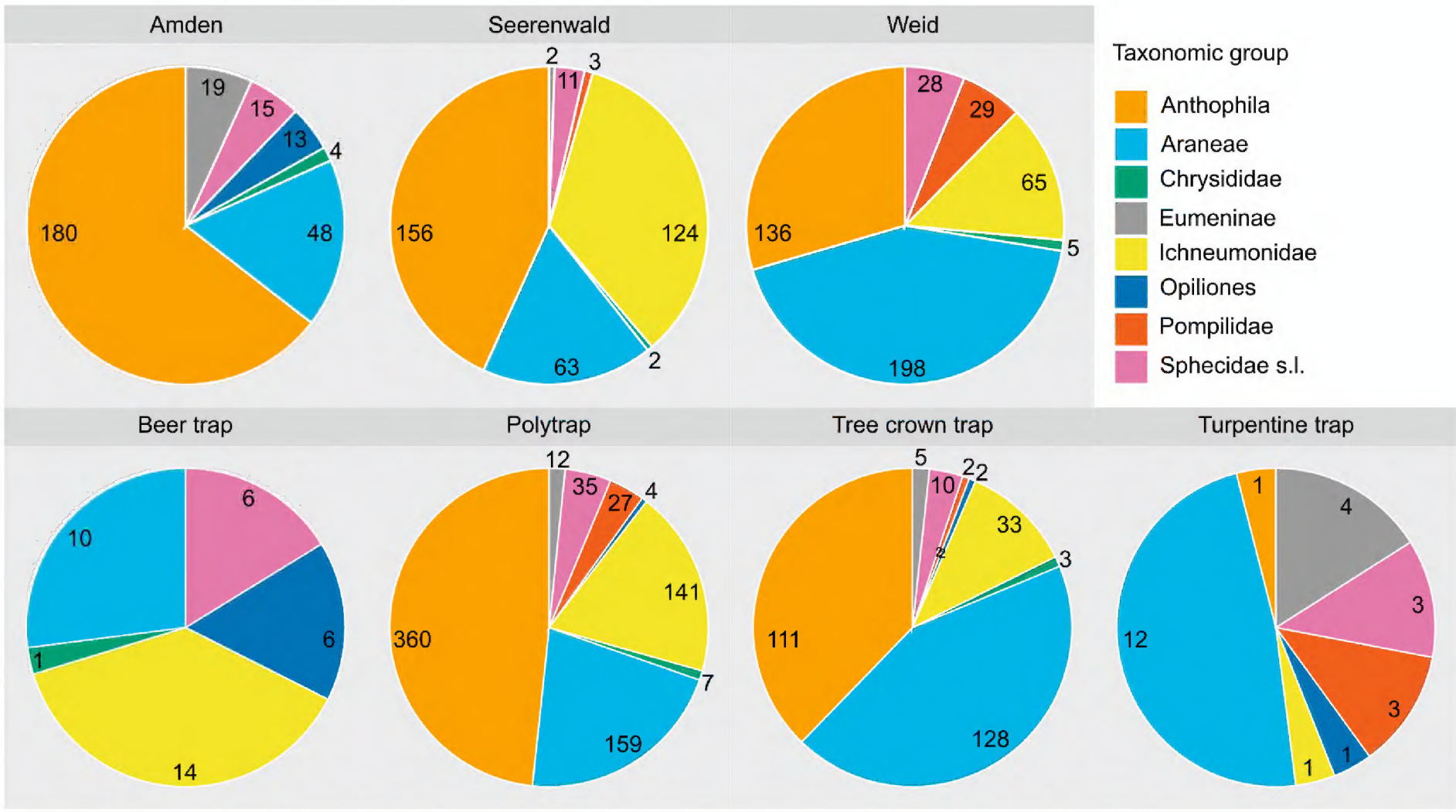

Figure 3. Total number of individuals recorded for each identified taxonomic group, organized by their occurrence across the three forest reserves (Amden, Seerenwald, Weid) and by trapping method (beer trap, polytrap, tree crown trap, turpentine trap).

in tree crown traps (Fig. 4 and Suppl. material 3). Ichneumonidae is the third most abundant group found in the bycatch samples (Suppl. material 3), with *Bioblapsis polita* (Vollenhoven, 1878) (Diplazontinae) being the most frequent species, particularly in the forest reserve Seerenwald and at various altitudes (Figs 4, 5, Suppl. material 3). The latter species was also most frequently found in polytraps and in tree crown traps (Suppl. material 3).

Remarkable findings

Remarkably, we found the first record for Switzerland of the ichneumonid species *Casinaria dubia* Tschek, 1871 in the forest reserve Weid. The examined material originated from Bollingen, St.Gallen. One female wasp was collected in July 2025 by Barbara Huber. Another ichneumonid species, *Bioblapsis polita* (Vollenhoven, 1878), has been observed in Switzerland after a 67-year absence. This species was found in remarkably high abundances in the two reserves Weid and Seerenwald. Furthermore, we found the rare European spider *Episinus maculipes* Cavanna, 1876 in the forest reserve Seerenwald. This species represents the first observation in eastern Switzerland. A detailed species list of all groups can be found in the Suppl. material 4.

Discussion

In this study, we analysed data originally collected to assess the diversity of xylobiontic beetles as indicators of ecological integrity in forest reserves. The resulting bycatch comprised a diverse range of arthropods of which we considered a total of 8 target groups in more detail (Fig. 3). Below, we provide an overview of the species and species compositions identified in the study areas and case types, as well as exceptional findings.

Composition of bycatch samples

As in the preceding study, most bycatch individuals were sorted from the two types of flight interception traps (Huber et al. 2019) (Fig. 2). Particularly, the target groups with the highest number of individuals and species (i.e., Araneae, Anthophila, Ichneumonidae), were primarily found in the poly- and tree crown traps. The beer and turpentine traps captured only a very small fraction of the bycatch individuals studied here (Fig. 4 and Suppl. material 2). The reasons for this presumably relate to the broad collection range of flight interception traps and the fact that the ecological niches of the groups identified here overlap with those of xylobiontic beetles. Many xylobiontic beetles, such as adult longhorn and jewel beetles, feed on pollen and nectar, similar to most adult Hymenoptera. Our results showed that traps with yellow bands (to mimic flowers) close to the herb layer (polytraps) or close to the tree blossoms (tree crown traps) are attractive for Anthophila und Ichneumonidae (Campbell and Hanula 2007; Vrdoljak and Samways 2012; Sukovata et al. 2020) (Figs 2, 3; Suppl. material 2). To avoid or minimize the number of bycatch specimens, the use of special odorants in the trapping solution can be helpful, as shown for

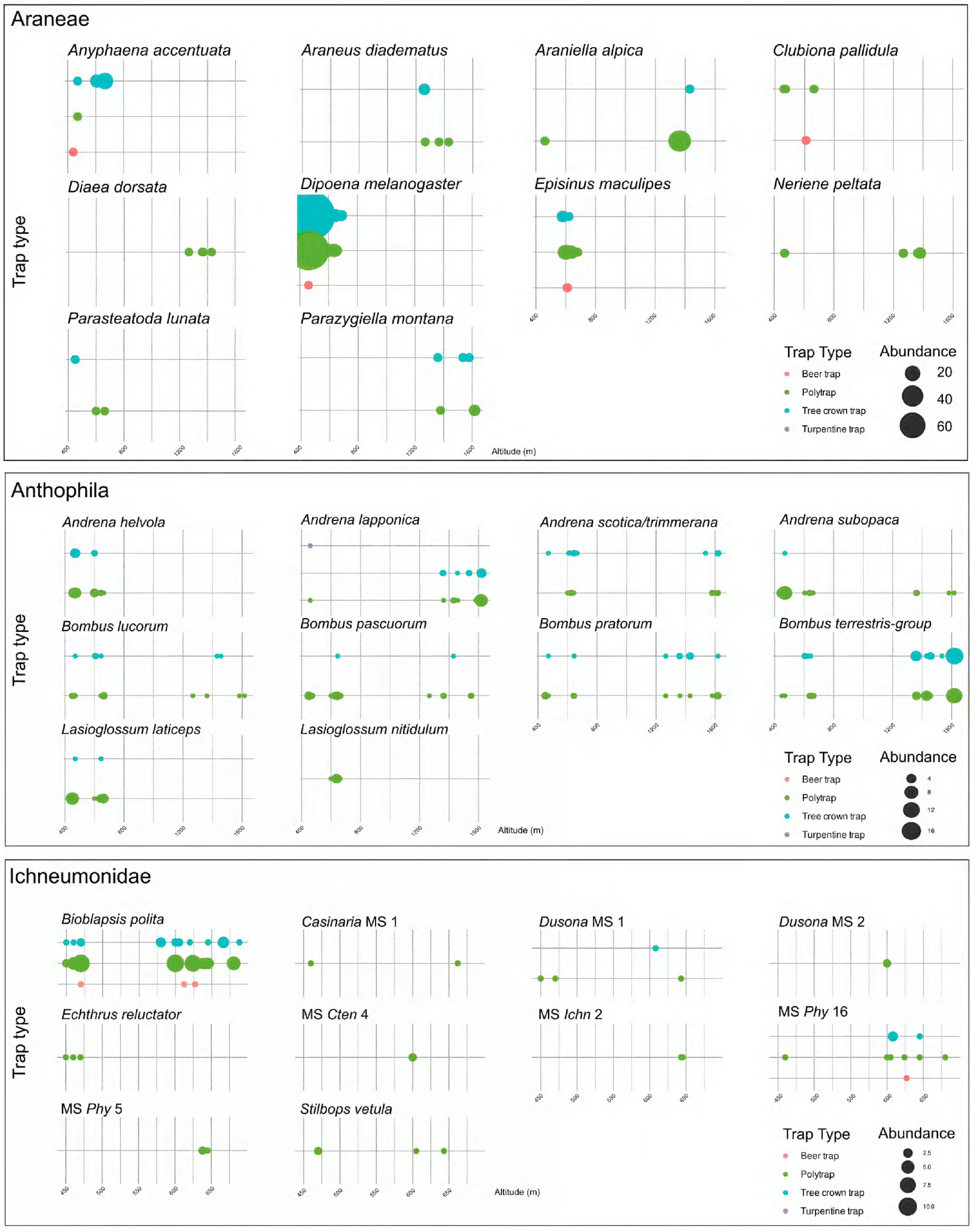

Figure 4. Overview of the ten most prominent species for the three representative taxonomic groups Araneae, Anthophila and Ichneumonidae identified in this study. The occurrence of the species is sorted by trap type (beer trap = red; polytrap = green; tree crown trap = blue; turpentine trap = purple) and altitude level (m). Bubble size represents the number of identified individuals per species.

example in studies on the Japanese beetle *Popillia japonica*. Nevertheless, bycatch cannot be prevented entirely (Sipolski et al. 2019). Also, the use of targeted attraction is not practical (even counterproductive) for studies on the diversity of specific groups or communities, as it can bias results. The present study shows that certain types of traps make only a minor contribution to species diversity assessments compared to others. Our data analysis implies that using polytraps and tree crown traps alone already collects a representative range of arthropods.

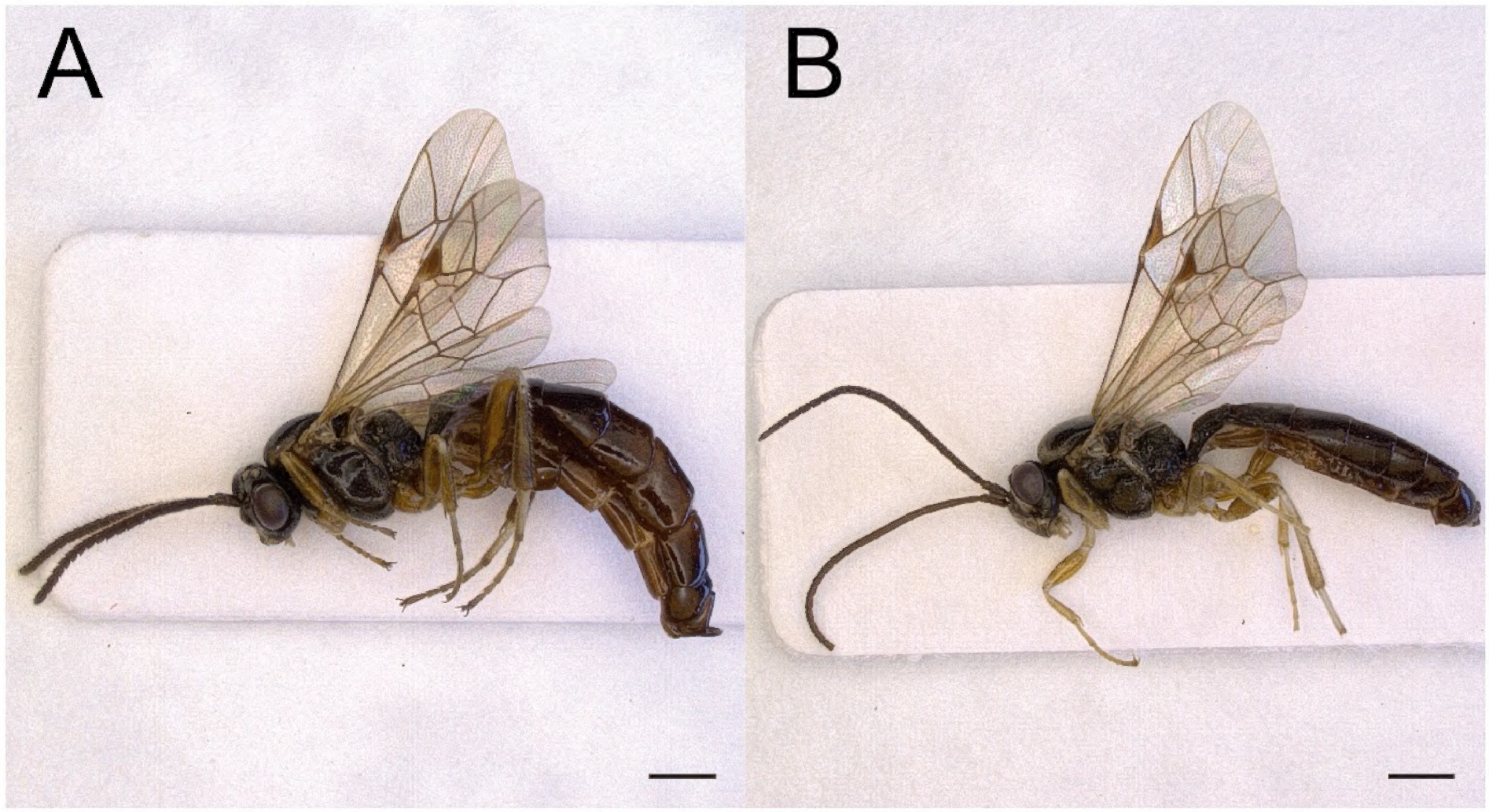

Figure 5. *Bioblapsis polita* (Vollenhoven, 1878) **A, B.** Habitus adults; **A.** Female in lateral view; **B.** Male in lateral view. (Pictures © Nina König). Scale bars: 1.0 mm (**A, B**).

Therefore, the additional effort of putting beer traps and turpentine traps does not seem justified in surveys that target the groups we analysed here (Suppl. material 2). Common capture methods for these groups can be found, for example, in Wheater, et al. (2020).

Remarkable records

The examination of the bycatch samples revealed the first record for *Casinaria dubia* for Switzerland. This discovery is not entirely surprising, as it is estimated that over 1,200 species of the Ichneumonidae family may be unknown in Switzerland (Klopfstein et al. 2019). The known distribution area of *C. dubia* comprises Austria, France, Germany, Hungary, Japan, and the United Kingdom (Riedel 2018). It is a solitary koinobiont endoparasitoid of Lepidoptera (Broad et al. 2018). Proposed host species are *Apatura metis substituta* Butler, 1873 (Lepidoptera: Nymphalidae), (not reliably known) *Eilema depressa* (Esper 1787) (Lepidopera: Arctiidae) and *Lithosia quadra* (Linnaeus, 1758) (Lepidoptera: Noctuidae), (Riedel 2018). More surprising, however, is the discovery of a rare ichneumonid species, *Bioblapsis polita.* It belongs to the subfamily Diplazontinae and was found in large quantities in polytraps and tree crown traps (Figs 4, 5 and Suppl. material 3). *Biolapsis polita* is distributed throughout the Western Palaearctic (Klopfstein 2014) and is a known koinobiont endoparasitoid of Syrphidae (Broad et al 2018). Described hosts are larvae of *Ferdinandea* Rondani, 1844, (Diptera: Syrphidae), which are ecologically unique in that they are saproxylic in the sap of over-mature trees, mostly oaks. The 76 specimens found in this study are a small sensation, given that the species is to date only represented in Swiss collections by a single female (Klopfstein 2014), and we know of no other collection that harbours more than a dozen specimens of this species. It is likely that these forest reserves are ideal habitats for their hoverfly hosts, which presumably spend most of their time at the level of the herbaceous layer visiting flowering plants. This is also where most of the *B. polita* were found in the polytraps.

Further, we found three bee species (Hymenoptera: Anthophila) that are listed as near threatened (NT) in Switzerland (Müller and Praz 2024): Firstly, in the forest reserve Weid we registered *Osmia uncinata* Gerstäcker, 1869, a bee species that prefers sparse, pine-dominated forests. In the reserve Amden we found *Megachile ligniseca* (Kirby, 1802), that prefers moist forests, forest clearings and edges, and in the reserve Seerenwald we found *Andrena combinata* (Christ, 1791), a species that prefers dry, warm and sunny locations.

Another highlight is the finding of a rare European spider of the family Theridiidae, *Episinus maculipes* Cavanna, 1876. Apart from the current record in the forest reserve Seerenwald (Supp. material 3), this species was not found before 1990 (Maurer and Hänggi 1990) and is only known from two other locations in Switzerland: Ticino around 1997 and Basel Land in 2003 (Info fauna 2025, https://lepus.infofauna.ch/carto/9682). The new record is the first for eastern Switzerland (Suppl. material 4). It is accompanied by three additional first records for eastern Switzerland: *Dictyna pusilla* Thorell, 1856, (forest reserve Amden), *Entelecara acuminata* (Wider, 1834) and *Clubiona caerulescens* L. Koch, 1867 (forest reserve Weid, respectively). Interestingly, even if spiders are more thoroughly studied than some other groups considered in our study (e.g., ichneumonids and

sphecid wasps), it shows that the distribution of many species in Switzerland is still not comprehensively sampled and recorded.

Storage of bycatch

Although bycatch samples are often analysed considerably later than the samples originally targeted in a study, they retain high ecological and conservation relevance. We highlight here the importance of storing and revisiting such samples, particularly those associated with multi-trap sampling and/or with a focus on specific target taxa resulting in a large proportion of bycatch. The preservation of samples in particular can be in determining whether bycatch can still be analysed years later. For example, the determination of Opiliones in our bycatch samples proved to be extremely difficult, as many important identification features were disrupted by the glycerol. Likewise, some important marks of colour or pattern may fade over time to the point of being barely visible, as for example, in the case of the Sphecidae *s. l.*. We recommend that the handling and curation of bycatch should be taken into account in accordance with group-specific requirements and included in future project planning, as for example previously recommended by Buchholz et al. (2011). In this study, the morphological evaluation of the specimens was still feasible, but the molecular evaluation was significantly more difficult due to the preservation conditions. Optimal preservation could also have made molecular validation possible here, especially, with increasingly fast and cost-effective molecular methods such as DNA (meta) barcoding. Thus, well-managed bycatch samples can serve as valuable collections to expand biodiversity inventories.

To conclude: When collecting invertebrates in field studies, many different types of traps are usually deployed to record a broad spectrum of fauna or to comprehensively record the diversity of a particular taxonomic group. Here, we highlight the importance of well-curated bycatch samples for biodiversity studies. We identified one species that represents a new record for Switzerland and in particular expanded the information on distribution areas of various species of Arachnida and Hymenoptera. Many monitoring projects have presumably collected or will collect large quantities of bycatch material. We therefore recommend curating these samples for future analyses, even beyond the duration of the project. The curation of the samples, (i.e., sample storage, choice of preservation agent in accordance with target groups and data recording) is essential and should be prioritized in future studies. Furthermore, collaboration with experts for various taxonomic groups and the use of molecular methods to identify bycatch samples are recommended.

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Supplementary material 1

Comprehensive overview on sampling information

Authors: Karin Urfer, Nina König, Yvonne Kranz-Baltensperger, Seraina Klopfstein, Oliver Niehuis, Adrien von Virag, Manuela Sann

Data type: xlsx

Explanation note: Sheet 1 refers to the general sampling information and sheet 2 refers to the detailed trap information.

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Link: https://doi.org/10.3897/alpento.9.168169.suppl1

Supplementary material 2

Overview of (a) individuals and (b) species found per taxonomic group in relation to trap type and location

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Data type: xlsx

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Supplementary material 3

Overview on the three most individual-rich bycatch groups

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Data type: xlsx

Explanation note: Given are the ten most abundant species per taxonomic group with relation to forest reserve and trap type.

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Link: https://doi.org/10.3897/alpento.9.168169.suppl3

Supplementary material 4

Detailed list of all species/taxa identified in this study

Authors: Karin Urfer, Nina König, Yvonne Kranz-Baltensperger, Seraina Klopfstein, Oliver Niehuis, Adrien von Virag, Manuela Sann

Data type: xlsx

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